INFORMATION CIRCULAR 37

Pennsylvania Geological Survey
Fourth Series

GEOLOGIC INTERPRETATION of AEROMAGNETIC MAPS

POTTSTOWN, WAGONTOWN, DOWNINGTOWN, COATESVILLE, UNIONVILLE, HONEYBROOK, & PARKESBURG QUADRANGLES

by

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1960

FOREWORD

Southeastern Pennsylvania is an area of extremely varied and complex geology with a long history of mineral production. The list of mineral commodities which this area has yielded at various times is considerable, but iron-ore stands out as the most prominent. Scores of iron mines and furnaces have operated in this area in the past 200 years. With a record of production dating back to Pre-Revolutionary War years, the mine at Cornwall is the oldest continuously operating iron mine in the United States. The recent development of the large and magnificent Grace Mine at Morgantown is living testimony to the fact that Pennsylvania's metallic mining record is not simply a story of the past. Through modern methods of exploration and research, new mineral resources remain to be found.

The Bureau of Topographic and Geologic Survey of the Department of Internal Affairs is pleased to have participated and cooperated with the United States Geological Survey in carrying out an aeromagnetic survey of Southeastern Pennsylvania. This modern exploration technique is particularly well suited to the geologic conditions and to the potential mineral resources of the area; it is an extremely efficient method of acquiring geologic data for a large region. The results of the aeromagnetic survey are being published by the United States Geological Survey as a series of aeromagnetic contour maps.

We are pleased to present this publication as a service to the Commonwealth of Pennsylvania. It is hoped that this interpretation and discussion of the aeromagnetic maps will serve as a stimulus for further research and development.

Genevieve Blatt

Genevieve Blatt, Secretary
Department of Internal Affairs

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General Statement

The magnetic contour maps being discussed in this series of publications are the result of a cooperative project of the United States Geological Survey and the Pennsylvania Geological Survey, Department of Internal Affairs. About 5,000 square miles of southeastern Pennsylvania have been covered in this survey, the results of which are being published as individual 7 1/2-minute quadrangle maps.

This information circular is one of a series intended as a preliminary explanation of the interrelation of distinctive magnetic features with geological conditions in each quadrangle. In many instances unusual magnetic patterns can be explained by geological features which have been mapped and studied in the past. It is hoped that the map viewer will not only be aided by such correlation of data, but that this publication may stimulate exploration and research in those areas where there is at present no known or satisfactory geological explanation for some of the magnetic features which appear on the magnetic contour map. Such exploration and research could directly or indirectly lead to discovery and development of new mineral deposits and would greatly further the basic knowledge of the geology of Pennsylvania.

The magnetic contour lines on the map are lines connecting points of equal magnetic intensity. The shape, position, and spacing of the magnetic lines are due to the combined effects of the earth itself, which is a huge magnet, and to the local variations in the magnetism of the rocks underlying any given area. If only the earth as a large, uniform body were responsible for the magnetic lines, they would be essentially straight and simple. It is the local geology, however, which imparts complexities to the patterns of the magnetic lines. Such complexities or variations from a simple pattern are called anomalies.

Local magnetic effects vary from place to place because the magnetic properties of the respective rocks are not alike or because differences in rock structure from place to place change the magnetism measured at the surface. Rocks which have different kinds or different relative amounts of minerals, particularly iron-bearing minerals, have unlike magnetic properties. In general, the more iron minerals present, the stronger the magnetic effect. The iron oxide mineral, magnetite, has a strong magnetic effect even when present in small quantities; when present in large amounts, magnetite is of economic interest as a possible iron ore.

If in a given area the rocks have been folded or faulted by internal earth forces, the resulting variation in position of the different rocks will be indicated by variation in magnetic readings from place to place. Thus, structural complexities as well as mineral variations may be revealed by the magnetic data. Of particular interest are those magnetic variations or anomalies which are circular or tend to enclose a given area; the implication in such cases is that there is a specific, localized causative factor more or less pin-pointed by such a pattern.

The aeromagnetic survey of southeastern Pennsylvania was carried out with the use of an airborne magnetometer, an instrument towed by a plane. The plane covered the area by flying back and forth along straight, parallel flight lines spaced a quarter mile apart. An attempt was made to maintain an elevation of 500 feet, above the ground so as to eliminate magnetic changes due solely to terrain changes. An airborne magnetic survey has the advantage of eliminating very minor magnetic features on the ground, thus permitting a better evaluation of larger and deeper magnetic phenomena. It should be borne in mind that the instruments which have measured the magnetic effects in these studies are very sensitive and capable of detecting small changes. Proper evaluation of these changes is necessary to distinguish those situations which offer possibilities for economic mineral development from those cases where the information yielded is of more academic interest.

Pottstown Quadrangle
U. S. Geological Survey Aeromagnetic Map G. P. 222

The Pottstown aeromagnetic map exhibits a marked correlation of magnetic contour pattern to geologic map pattern. The northeastern portion of the magnetic map shows essentially no contour lines, denoting no variations in magnetic intensity; that area is underlain by a thick sequence of Triassic sandstones and shales.

The more complex magnetic patterns in the western and southern portions of the map reflect the diabase and the older crystalline masses in those areas respectively.

An elongate, positive magnetic anomaly extends southeasterly to a point about a mile east of Harmonyville in South Coverntry Township and then swings to a southwesterly trend. This anomaly of about 200 gammas magnitude is located over Triassic sandstones and shales along the line of outcrop of the upper contact of a dipping sheet of intrusive diabase. In the Harmonyville area the diabase forms the eastern end of a large basin-like sheet. The contact metamorphism of the ferruginous sediments has resulted in development of sufficient magnetite to cause the anomaly, but not enough to be of economic significance.

Superimposed on the linear, contact-effect anomaly described above, is a small, sharp, positive anomaly at Saint Peters. This oval-shaped anomaly, less than a mile long, occurs over the old French Creek iron mines. Here the ore occurred as magnetite replacement of a north-dipping limestone bed within Pre-cambrian biotite gneiss. The gneiss also contains quartz, feldspar and graphite and is probably of sedimentary origin. The mines were opened in 1850 and operated until 1928 when the ore is reported to have been exhausted; total production was 876,000 tons. The shaft went to a depth of 1400 feet; the orebody averaged 75 feet in thickness and was mined for 1700 feet along its trend. The mineralization is believed to be of hydrothermal origin, genetically related to the nearby intrusive Triassic diabase. Associated with the magnetite mineralization was calcite, chalcopyrite, sphalerite, bornite, pyrrhotite, pyrite, and hematite. The low amplitude of the St. Peters anomaly tends to support the reports that the French Creek ore was essentially worked out.

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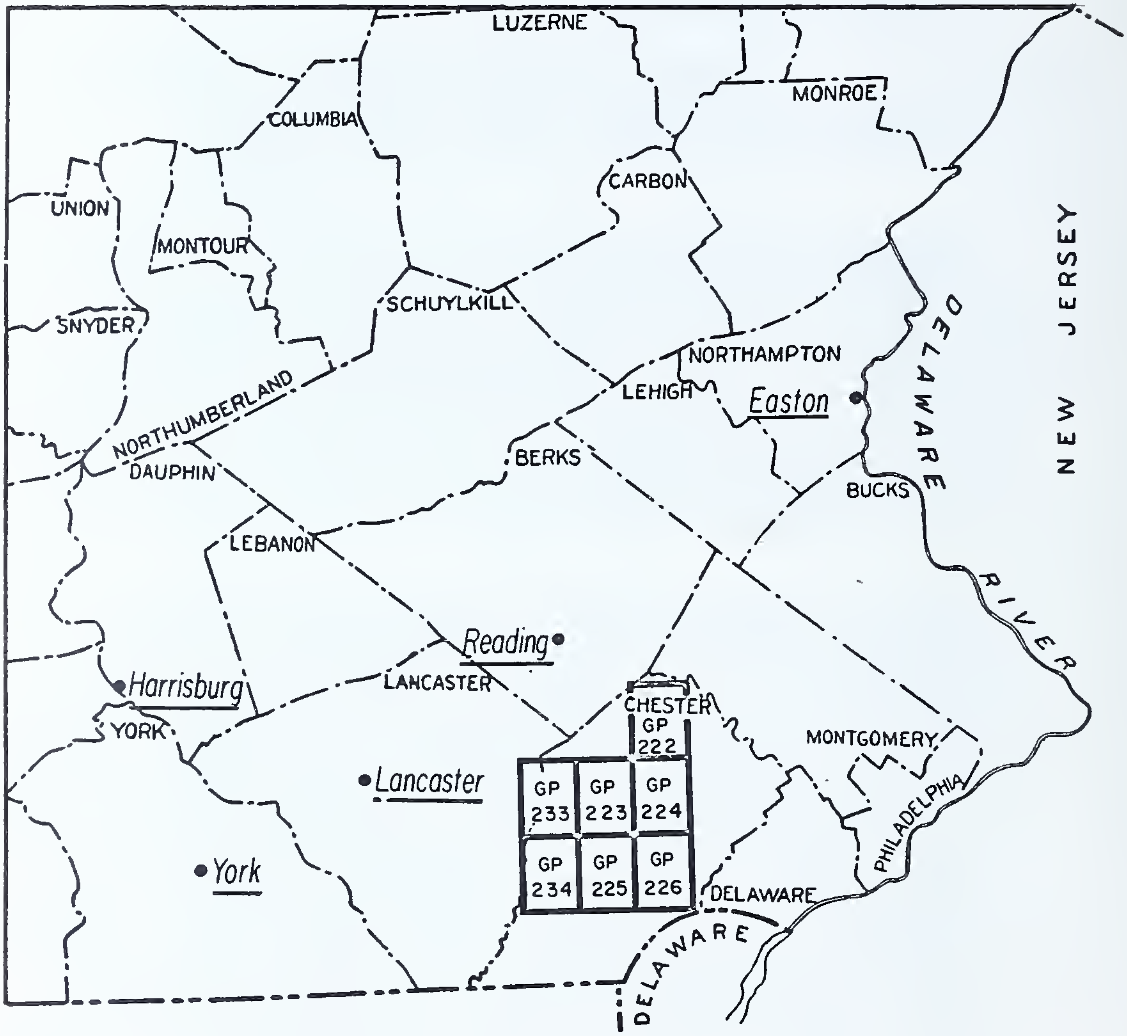

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An elongate, positive magnetic anomaly occurs south of Pughtown along French Creek in West Vincent Township. This is a low amplitude anomaly of less than 150 gammas and is probably indicative of a slight concentration of magnetite and other iron-bearing accessory minerals which have been found in the Pickering gneiss of this area. No iron concentration of economic proportions is indicated.

A small circular positive anomaly of nearly 200 gammas amplitude occurs in West Vincent Township, about a mile east of Nontmeal Village. This anomaly occurs over a topographic knob of quartz monzonite. A very small concentration of magnetite coupled with the effect of the topography readily account for this anomaly. No economic concentration of iron is indicated.

Bibliography

Bascom, F. and Stose, G. W. (1958), Geology and Mineral Resources of the Honeybrook and Phoenixville Quadrangles, Pa.; Bull. 891, U. S. Geol. Survey.

Smith, L. L. (1931), Magnetite Deposits of French Creek, Pa.; Bull. M 14, Penna. Geol. Survey, 4th series.

Wagontown Quadrangle
U. S. Geological Survey Aeromagnetic Map G. P. 223

The Wagontown quadrangle is an area underlain primarily by a variety of crystalline rocks, both metamorphic and igneous. The aeromagnetic map patterns of the quadrangle indicate that though there is not a large contrast in magnetic intensities among the different rock types, there is enough to delineate their respective distribution. A large oval area of anorthosite which makes up much of the northern half of the quadrangle is defined by a belt of small anomalies along its border. An area of gabbroic gneiss in the southwest corner of the quadrangle results in a complex positive magnetic anomaly which is a contrast to the almost featureless pattern over the granodiorite in the southeast.

A positive magnetic anomaly in Honeybrook Township, a mile west of Rockville is the largest of a number of similar anomalies which encircle the large area of anorthosite in the northern half of the quadrangle. This anomaly has a diameter of nearly a mile and an amplitude of 350 gammas. A smaller anomaly in a similar geologic setting occurs at Brandywine Manor and three others occur south and north of Glenmore in Wallace Township. These anomalies at the margin of the anorthosite mass may be attributed to an iron silicate and iron-oxide-rich border zone as reported by Bascom (1938, p. 38). The petrology of such a zone and its genetic relationship to the anorthosite make an interesting academic problem. However, neither the anomalies nor the general lithologic sequence indicate any iron concentrations of economic interest.

In the southwest corner of the quadrangle is a large, complex, positive magnetic anomaly nearly 2 miles in diameter with an amplitude of approximately 500 gammas. The anomaly actually has three separate peaks about a half mile apart. The overall anomaly occurs in an area where two large masses of gneissic gabbro and granodiorite form a complex intertonguing contact with each other. Each of the three peaks within the overall anomaly is centered over a line of contact between gabbro and granodiorite; each of these rock types has variable amounts of magnetite present as an accessory mineral and it appears that this overall anomaly has formed over an area when there is a somewhat greater amount of magnetite present than is usual for these rocks. Neither the amplitude or sharpness of the anomaly, nor the nature of the lithologies involved, offer any encouragement as to the possibility of an economic concentration of iron ore.

A positive anomaly occurs about a mile southeast of Brandywine Manor and another about 2 miles southwest of Brandywine Manor. Each of these is a little under a mile long and has an amplitude of about 150 gammas. These anomalies are developed over gneissic granodiorite in which magnetite occurs as an accessory mineral. It is a small concentration of magnetite which is responsible for these anomalies but no iron concentration of minable scope is present here.

Bibliography

Bascom, F. and Stose, G. W. (1938), Geology and Mineral Resources of the Honeybrook and Phoenixville Quadrangles, Pa.; U. S Geol. Survey Bull. 891.

Downingtown Quadrangle
U. S. Geological Survey Aeromagnetic Map G. P. 224

The Downingtown aeromagnetic map exhibits no distinctive magnetic pattern. It is primarily an area underlain by igneous and metamorphic rocks which apparently do not have major magnetic concentrations or linear trends. Along the southern edge of the quadrangle the magnetic contour lines are few and widely spaced; an area underlain by folded lower Paleozoic sediments of apparently uniformly low magnetic intensity.

A few anomalies do stand out in the crystalline area of the quadrangle. One is located along the western edge of the quadrangle, just north of the Pennsylvania Turnpike in East Nontmeal Township. The anomaly occurs over a topographic knob of quartz monzonite; the amplitude of less than 200 gammas suggests that the topography plus only a very small concentration of iron minerals are responsible. No iron concentration of economic scope is indicated.

An elongate positive anomaly occurs about a mile south of Lyndell in East Brandywine Township. The anomaly is located over crystalline granodiorite which in this area has somewhat of a concentration of dark, iron-rich minerals including a little magnetite. This is a low amplitude anomaly of about 200 gammas and offers no encouragement for an economic concentration of iron minerals.

Several other small oval-shaped positive anomalies occur in this quadrangle. One is southeast of Anselma in West Pikeland Township; another is southeast of Lionville in Uwchlan Township; a third is just north of St. Mathews and a fourth is just north of Ludwigs Corner in West Vincent Township. Each of these positive anomalies occurs over gneissic crystalline rock which is dark colored and richer in iron minerals. These anomalies each have amplitudes of less than 200 gammas and there is no indication of concentration of iron minerals in economic quantities.

Bibliography

Bascom, F. and Stose, G. W. (1938), Geology and Mineral Resources of the Honeybrook and Phoenixville Quadrangles, Pa.; Bull. 891, U. S. Geol. Survey.

The magnetic patterns on the Coatesville aeromagnetic map in general delineate the mapped geologic units. The northern third of the map is an area of relatively few, widely-spaced magnetic contours; this is an area underlain chiefly by a belt of Cambrian and Ordovician sandstones and limestones as well as a belt of the chloritic phase of the Wissahickon schist.

The southern two-thirds of the map shows numerous magnetic anomalies of different shapes and sizes, as well as a considerable variation in spacing and orientation of the magnetic contours. This area is underlain chiefly by Peters Creek schist and by the oligoclase phase of the Wissahickon schist. Intense folding in this part of the quadrangle has created complex nappe structures and fold axes with orientations which contrast the structures to the north; the variation in structural trends is well indicated. It is interesting to note that there is no break in pattern between the Cambro-Ordovician sediments and the chloritic Wissahickon schist, even though the Martic thrust has been said to separate the two unlike lithologic units. Actually, a more distinct change in magnetic pattern occurs at the contact of the chlorite and oligoclase phases of the Wissahickon Formation.

An elongate, positive anomaly occurs in West Bradford Township, about a mile northeast of Mortonsville. The anomaly trends northeasterly, is less than a mile long, and has an amplitude of just under 150 gammas. Though that location has been mapped as being within the belt of chloritic Wissahickon schist, the anomaly pattern is much more like that which occurs in the adjacent Peters Creek schist or in the oligoclase phase of the Wissahickon schist. A revision of the contact may thus be in order. In any case, only a very small increase in magnetite content could cause this small anomaly and no concentration of iron in economic proportions is indicated.

In East Fallowfield Township, about half a mile southwest of Youngsburg, and just south of Brandywine Creek in Newlin Township are two positive anomalies, each less than a mile long and each with an amplitude of about 100 gammas. These anomalies occur over Peters Creek schist which in various places has been found to carry small concentrations of magnetite. Actually, the pattern of these small anomalies is very similar to that which occurs with the Wissahickon oligoclase facies and it is conceivable that structure in these crystallines places that Wissahickon unit at a shallow depth beneath these anomalies. In any case, these two anomalies offer no indication of any economic mineral concentrations.

Three elongate positive anomalies occur over oligoclase-bearing Wissahickon schist along the boundary between East Fallowfield and West Marlboro townships. One is located a mile north of Doe Run; it is less than a mile long and has an amplitude of about 100 gammas. Another is located half a mile east of Doe Run; due to incomplete coverage of this quadrangle, the southern part of this anomaly is not closed but an amplitude of over 200 gammas is indicated. The third anomaly of this group is located 2 miles southeast of Doe Run and has an amplitude of 100 gammas. Each of these three anomalies is located over a topographic high of oligoclase-bearing Wissahickon and, on the basis of projection from a mile or two to the south, each of the anomalies is located over a structural nose which involves the Wissahickon rocks as well as the older crystalline rocks of the Baltimore gneiss. Small concentrations of magnetite are indicated but no commercial concentration of iron minerals appears to be present.

Bibliography

Bascom, F. and Stose, G. W. (1932), Coatesville-West Chester; U. S. Geol. Survey Folio 223.

Unionville Quadrangle
U. S. Geological Survey Aeromagnetic Map G. P. 226

The Unionville quadrangle has been mapped aeromagnetically only in the northern half. The most distinctive magnetic pattern on the map consists of a series of very elongate, parallel magnetic anomalies which occur over the oligoclase-mica facies of the Wissahickon schist. The chloritic facies of the Wissahickon schist shows little or no magnetic expression, nor does the granitic gneiss or the gabbroic gneiss.

A portion of a large positive magnetic anomaly, nearly a mile wide and probably 3 miles long, appears in Newlin Township between Unionville and Marshallton. This anomaly has an amplitude of about 250 gammas and is located over a serpentized mass within the oligoclase-bearing Wissahickon Formation. The serpentine rock of this region characteristically develops such anomalies due to the presence of small blebs of magnetite. No magnetite concentration of commercial proportions is indicated at this anomaly, either by the field evidence or by the magnetic data.

Two small positive anomalies are located a half mile north and a half mile southwest of the town of Altor in East Bradford Township. These anomalies of about 100 gammas amplitude are both located over oligoclase-bearing Wissahickon schist and are attributable to very small amounts of disseminated magnetite. No economic iron concentrations are at all indicated.

Bibliography

Bascom, F. and Stose, G. W. (1932), Coatesville-West Chester; U. S. Geol. Survey Folio 223.

Honeybrook Quadrangle
U. S. Geological Survey Aeromagnetic Map G. P. 233

The Honeybrook quadrangle includes a large variety of sedimentary, metamorphic and igneous rocks, all involved in complex structures. The aeromagnetic map of this quadrangle exhibits on the whole, a single, non-distinctive magnetic pattern; there is only a subtle increase in complexity of magnetic pattern over the crystalline rocks.

Two small, positive magnetic anomalies occur in Salisbury Township, about 3 miles west of Honeybrook. Each of these anomalies is developed over a serpentine mass within an area of gneissic gabbro. These are small anomalies; each is less than a half mile in diameter and each has an amplitude of about 250 gammas. These are similar to other anomalies associated with serpentines in the Philadelphia area and are attributed to small amounts of magnetite which are commonly found with the serpentines. No iron concentration of economic scope is indicated, however.

A positive magnetic anomaly less than a mile in diameter with an amplitude of 150 gammas straddles the Lancaster-Chester County line, about a mile north of Cambridge. This occurs over an area of gneissic granodiorite with associated Pickering gneiss. This anomaly is neither large nor sharp and can be attributed to a very minor accumulation of magnetite which is common in those gneisses. No significant iron concentration is indicated.

A positive anomaly, about a half mile in diameter with an amplitude of 150 gammas, occurs about 2 miles southeast of Honeybrook. This anomaly is over the contact of a mass of quartz monzonite with granodiorite and appears to be due to a minor concentration of magnetite which has no economic possibilities.

Bibliography

Bascom, F. and Stose, G. W. (1938), Geology and Mineral Resources of the Honeybrook and Phoenixville Quadrangles, Pa; U. S. Geological Survey Bull. 891.

The magnetic contour patterns of the Parkesburg quadrangle tend to reflect the major rock types of the area. A belt of anomalies at the southern edge of the map is correlated with an area of Peters Creek schist. North of that, a northeast-trending belt of chloritic Wissahickon schist results in no anomalies and practically no magnetic contours on the map. Similarly, only a few, simple magnetic contours are developed over the adjacent belt of lower Paleozoic limestones and sandstones which cuts across the center of the quadrangle. In the northern third of the quadrangle, an area underlain chiefly by Precambrian crystalline rocks, there are several small, low-amplitude anomalies.

A sharp, circular positive magnetic anomaly occurs one mile north of Cochranville in West Fallowfield Township. The anomaly is only a half mile in diameter and has an amplitude of 300 gammas. It is developed over a broad area of Peters Creek schist. A shallow concentration of magnetite is indicated at this location; this is consistent with the fact that the Peters Creek Formation is known to carry disseminated magnetite. While some concentration of magnetite probably exists here, the anomaly indicates it is very limited in size, to the extent that it would not be adequate for mining purposes.

An elongate, north-south trending positive anomaly occurs 3 miles northeast of Cochranville. The anomaly is 2 miles long, about a half mile wide, and has an amplitude of 500 gammas. The north-south trend corresponds with similar features in the adjacent Coatesville quadrangle; it is a manifestation of extremely complex folding which has developed axial trends that are unlike those farther north. The anomaly occurs over an area which is mapped as Peters Creek Formation but the general characteristics of the anomaly are more like those which are associated with the oligoclase variety of the Wissahickon Formation. Inasmuch as the Peters Creek Formation rests on the Wissahickon Formation here, it may well be that the latter is the source of the anomaly; possibly it is a magnetite-bearing iron silicate zone such as has been observed elsewhere. No iron concentration of economic significance is indicated.

In the northeast corner of the quadrangle, a small, positive, elliptical anomaly occurs about a half mile north of Sodsburyville. This anomaly of about 150 gamma amplitude, may be related to a small mass of serpentine rock which has been recognized in that area. Magnetite is commonly associated with the serpentines of this region. Neither the size, nor amplitude of the anomaly suggest anything more than a very minor concentration.

Bibliography

Bascom, F. and Stose, G. W. (1932), Coatesville-West Chester; U. S. Geol. Survey Folio 223.